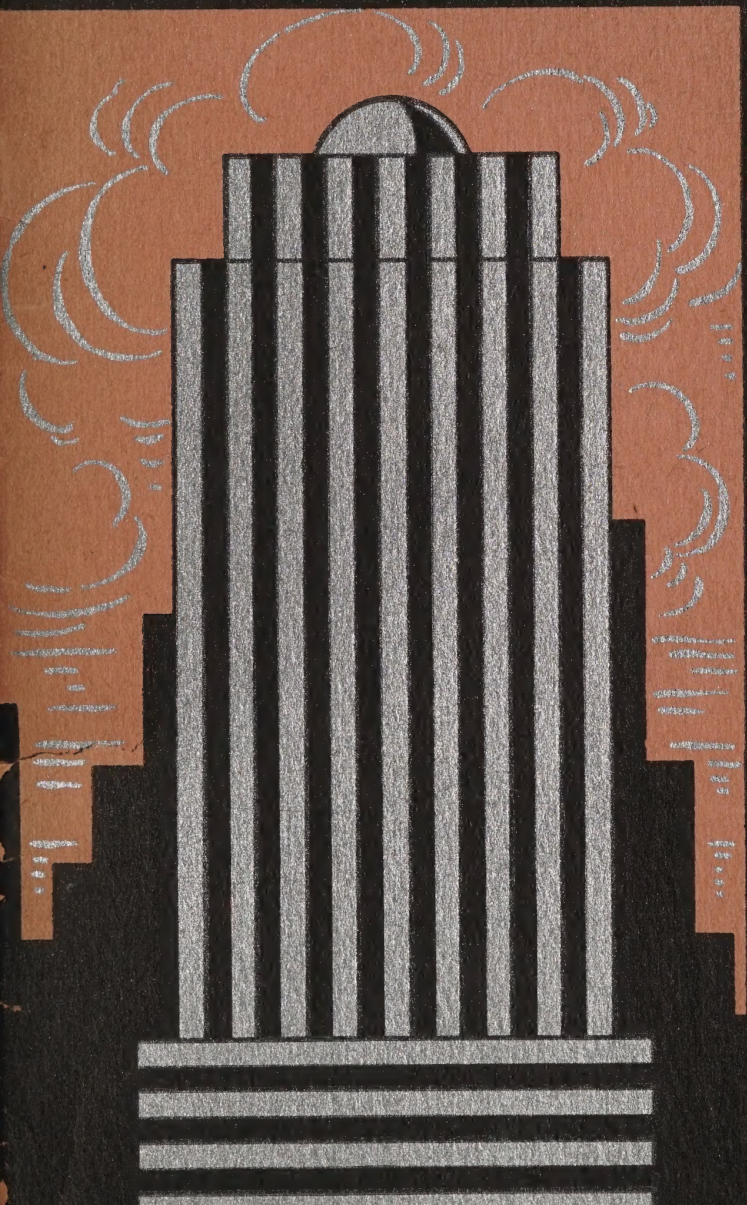
ALUMINUM

FOR ARCHITECTURE



BACO Ltd

ALUMINUM FOR ARCHITECTURE

THE BRITISH ALUMINIUM CO., LTD.

PRODUCERS OF VIRGIN ALUMINUM

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Second Edition

EROS

A cast aluminum statue. Placed in Piccadilly Circus, London, in 1893.

ALUMINUM
FOR ARCHITECTURE

The Architect controls the consumption of a vast amount of materials and is especially interested in being acquainted with all materials likely to be suited to his purposes.

Metals have opened new fields to the Architect, giving broader scope for size, safety and economy, and surely with aesthetic possibilities.

As steel is used for the skeletons of structures to carry the loads, so Aluminum is a logical material for their covering and adornment.

In this monograph is respectfully presented to the Architect technical information of interest about Aluminum and its alloys.

ADVANTAGEOUS CHARACTERISTICS AND APPLICATIONS OF ALUMINUM

Aluminum functions perfectly as the outer covering of walls and roofs.

It can be applied in large, thin, light slabs, giving considerable economy in cost, transportation and erection in comparison with other materials.

It can be joined and attached with much greater security than stone or brick.

Aluminum has adequate strength and is tough. It cannot be damaged by tremors, tempests, rain or frost.

It does not necessarily require repainting or other costly upkeep.

It resists the corrosive action of the weather.

It does not rust nor cause stains.

It is waterproof.

It is non-inflammable and incombustible.

A bright surface of aluminum has a low absorptive and radiative power for heat.

Aluminum has a light density — 1-10th pound to the cubic inch, 168 pounds to the cubic foot. It is only one third as heavy as iron or copper, and one fourth as heavy as lead.

The light weight and adequate strength of aluminum are of particular advantage where low mass or inertia are required and it is thus the ideal material for doors, window frames and elevator cabs.

For ornamental purposes, aluminum is a most suitable material by reason of its permanence and the ease with which any imaginable shapes can be reproduced. In appearance it is effective both at distance and close up.

Owing to its high thermal conductivity, aluminum is well suited for use in steam radiators. It enables these to be made small and compact, which is of particular value when they are to be built into the walls.

ADAPTATION OF ALUMINUM TO ARCHITECTURE

Aluminum can be used in cast or wrought form.

Castings, as is well known, are made by the ancient art of "casting" (or pouring) the molten metal into molds of sand or other material, the aluminum then solidifying to the required shape and size. In this way any conceivable shape can be readily reproduced, no matter how intricate, provided that a pattern in wood, wax or other easily cut material is available to begin with. An indefinite number of reproductions can be made from one pattern. Large castings can be made in sections which can afterwards be fastened together by simple mechanical means. Shapes required in architecture for spandrels, finials, cornices, etc., are straightforward work for the aluminum founder. Good craftsmanship will insure a smooth surface and perfect detail in aluminum castings. For flat pieces, such as spandrels, and other wall panels, large plates as thin as 3/16" can be cast, carrying any design required on the exposed surface.

In the wrought form, aluminum is rolled into plates or sheets, also bars and structural sections. It is also extruded into bars or sections of any required cross-sectional shape. Extruded sections are useful for mouldings and other trim, also for sash, window sills or stair-treads. These forms can be produced in long lengths. Sheets or strips can be further formed into sections and shapes suitable for trim, doors, etc. In sheet form the metal is particularly suited for roofing. The obvious advantage of using sheets, either flat or formed, is that the metal can be thinner than in any other form, although excessive thinness is to be avoided as a ruggedness of construction is always more satisfactory.

A Toronto building with spandrels and clock mount of aluminum.

PURE ALUMINUM

Virgin aluminum as produced commercially from the bauxite ore has a purity around 99%, the only impurities being small quantities of iron and silicon making up the balance.

The pure metal is somewhat soft and somewhat difficult to make into castings. In the form of extruded sections or formed sheet it is suitable for trim. Hard-rolled sheets are available which may have up to twice the stiffness and strength of the metal in its soft or annealed state, and it is advantageous to use these for doors, trim, etc., owing to their greater rigidity and resistance to indenting. Extruded pure aluminum sections are necessarily soft, but tubes are produced "hard drawn."

ALUMINUM ALLOYS

For fixtures and fittings subject to handling and requiring strength as doors, gates, windows, balustrades, furniture, a somewhat harder and stronger material than pure aluminum is often desirable, and a suitable aluminum alloy should then be used.

For load-bearing members of a structure, material of maximum strength is required, and for this there is available the well known alloy Duralumin, strongest and best of aluminum alloys, equal in strength to ordinary structural steel.

For castings, aluminum alloys are invariably used, as they are easier to cast than the pure metal.

The selection of the aluminum alloy is a most important matter.

Long experience has shown that there are only a limited number of alloys suitable for foundry purposes and for working. Of these, all are not suitable for architectural purposes, as the presence of certain other metals has a tendency to diminish the high corrosion resistance of the pure metal.

CAST ALLOYS:

The most suitable alloy for architectural aluminum castings is one of aluminum and silicon in the proportion of 95 to 5. This has not only excellent casting properties, enabling high soundness and perfect detail to be obtained with a smooth bright surface in the castings, but it also has a high resistance to corrosion similar to that of pure aluminum. In this alloy, the only impurity present should be iron, to the extent of .2% to .4%. The presence of other impurities will tend to impair its high corrosion resistance.

For castings that are to maintain a good bright surface when exposed to the weather, alloys containing copper are less suited than the above.

Where castings are intended to be highly stressed in carrying loads, a high strength alloy is required, and for this purpose heat-treated castings of the well known "Y" alloy are to be recommended as having a high strength coupled with good corrosion resistance. The composition of "Y" alloy is Copper 4%, Nickel 2%, Magnesium 1½%, balance Aluminum. This alloy was developed in England during the War.

WROUGHT ALLOYS:

As mentioned above, the best wrought alloy for aluminum members that are required to carry any considerable load is Duralumin. This alloy was developed by Wilm over twenty years ago. Its composition is Copper 4%, Magnesium .4%, Manganese .7%, balance Aluminum. This alloy is heat treated after fabricating and should only be used in the properly heat treated condition as its corrosion resistance and mechanical properties are then at their best. Its tensile strength in this condition is not less than 55,000 pounds per square inch, which is comparable to that of mild steel.

For extruded sections as used for window sash, the 95/5 aluminum silicon alloy is satisfactory.

A heat-treated aluminum alloy containing small quantities of magnesium and silicon is well suited to certain purposes, such as furniture and window sash.

For sheet which is required for forming door frames, doors, trim, etc., where something harder than hard-rolled pure aluminum sheet may be desirable, an aluminum alloy containing 1¼% manganese could be used advantageously. The 95/5 aluminum silicon alloy is also available in sheet form and is suitable for such purposes also. These alloy sheets are advantageously used in the half-hard-rolled condition in order to combine good stiffness with sufficient workability.

FINISHES

Aluminum can be given a variety of finishes.

The metal and its alloys take a perfect polish with a beautiful white lustre. Aluminum, not being very hard, is comparatively cheap to polish. Unsuitable aluminum alloys may soon lose their polish but the pure metal or aluminum-silicon alloy, if of high quality and freedom from impurities, can be counted on to retain good lustre. Of course some settlement of dust from a city atmosphere is bound to take place and where the metal cannot be wiped down occasionally this dust would naturally tend to diminish the original lustre, but even so a polished aluminum surface will retain a pleasing appearance.

Where a specially white and hard polished surface is required aluminum may be chrome-plated. If this is correctly carried out, the results will be satisfactory.

A very beautiful "satin" finish can be readily imparted to aluminum by lightly scratch-brushing with a soft brass wire mechanical brush. A somewhat similar effect can also be produced by rubbing over by hand with sand paper. The satin finish is semi-lustrous.

A semi-lustrous "curled" finish can be obtained by a simple mechanical polishing operation, and this is very effective on flat surfaces seen at close range.

A permanent light grey matte finish is obtained by sand-blasting.

A permanent white matte finish can be obtained by dipping in certain chemicals. Care must be taken that the pickling chemicals are thoroughly washed off.

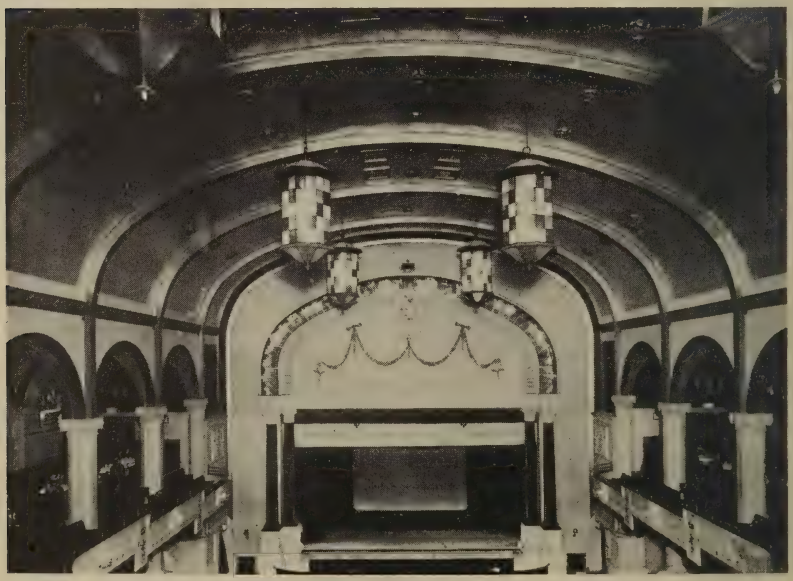
The aluminum-silicon alloy can be given a permanent dark grey colour by means of an "anodic" electrolytic dip. This can be used in combination with subsequent polishing or satin-finishing of highlights if desired, whereby some very nice effects can be obtained. This dark grey coating cannot be applied to pure aluminum, the anodic coat being light grey in this case.

The anodic oxide coating on aluminum can be dyed with aniline dyes to give any desired colour. These dyed colours are not "fast" enough for use out of doors but could be satisfactorily used indoors away from the daylight. The anodic oxide coat is hard and wear-resisting.

By certain chemical processes, aluminum may be given permanent oxidised finishes with dull colours, such as brown or black.

Aluminum and its alloys can be painted or lacquered as well as any other material — in fact the metal offers economies over wood in this respect owing to the fewer coats required. A dipped or frosted surface of aluminum is the best for taking paint. One of the virtues of aluminum, however, is that it does not need the protection or embellishment of paint and this constitutes one of the major economies to be derived from the metal.

In the case, however, of the high strength alloys (cast "Y" alloy or wrought Duralumin) a protective coat of paint is advisable, and for this purpose aluminum paint has superior protective properties.



A Birmingham (Eng.) cinema theatre with aluminum ceiling.

CONTRASTING METALS

Coloured metals such as copper, brass or bronze are sometimes applied in decorative patterns to an aluminum background.

In this connection, a warning must be given not to place any other metal (except zinc) in direct metallic contact with aluminum. If this is done, a galvanic action will take place in the presence of moisture, and the aluminum will tend to be dissolved or corroded. To avoid such a result, the dissimilar metal must be effectively insulated from the aluminum, which can readily be done by painting the contiguous surfaces with a bituminous or asphaltic paint, which should be allowed to harden before the metals are set together.

ALUMINUM BRONZE

Where a contrasting metal is required, aluminum bronze containing up to 10% aluminum (balance copper) is worthy of consideration. This has a true golden colour and when polished, will retain its beautiful appearance for long periods.

This particular bronze is extremely resistant to corrosion, and in addition is among the strongest of the bronzes. It can be both cast and wrought.

JOINING ALUMINUM

Aluminum cannot be satisfactorily soldered by any "soft-soldering" method. There is a good "hard-soldering" method available using a soldering wire of 90/10 aluminum silicon alloy and a suitable flux.

There is also available autogenous welding with an oxyhydrogen flame, using a filler rod of the same composition as the metal being welded, and a suitable flux to make the joint run nicely together.

An aluminum store front.

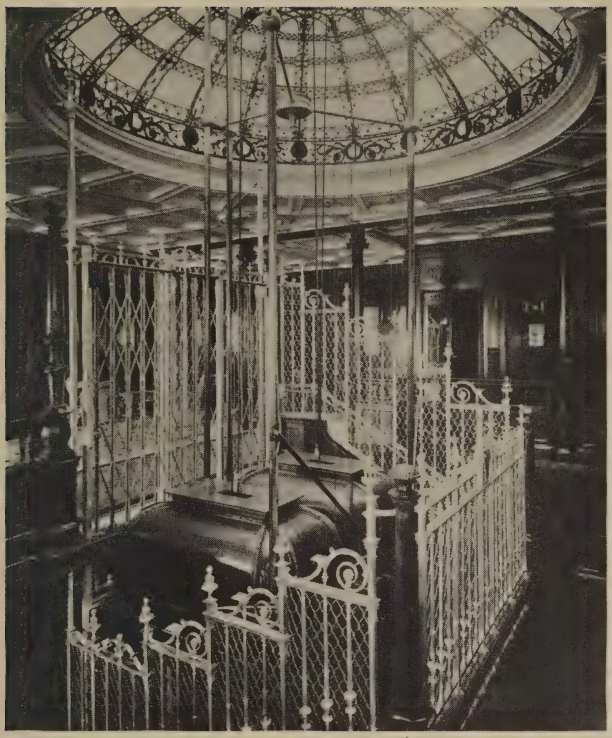
Generally speaking, however, in architectural work mechanical joints using bolts, screws or rivets are more adaptable than welded joints.

Aluminum rivets are available and should be of the same composition as the aluminum or aluminum alloy being joined, as nearly as possible. No other metal should be used as rivets for aluminum. Aluminum rivets are nearly always driven cold.

Bolts and screws for joining aluminum should be of galvanized wrought iron or mild steel, or of heat-treated Duralumin.

ADVISABLE PRECAUTIONS

Aluminum is attacked by alkalies such as soda, potash and lime (though not by ammonia). For this reason some care is needed that cement or mortar are not set in contact with aluminum or its alloys.



The aluminum elevator enclosure of S.S. Mauretania, which made her maiden voyage Nov. 16, 1907, remains in perfect condition.

Where it is necessary to build aluminum window-frames, spandrels, or door frames into a masonry wall, it is advisable that the surface of the aluminum that is to be in contact with the masonry should be coated beforehand with bituminous or asphaltic paint which should be allowed to harden before the parts are built in.

Aluminum is also rapidly attacked by hydrochloric acid. Therefore if this acid is used for cleaning down masonry, it should not be allowed to come into contact with the aluminum.

Assurance can here be given that the above named chemicals, to which can be added hydrofluoric acid, are the only common chemicals which attack aluminum.

As in the case of all other common metals it is wise to avoid any strongly corrosive conditions. It is well known that corrosion will take place most strongly at a water-line, i.e., at the line where air, water and metal meet. For this reason, the lodgement of stagnant water should be avoided wherever possible. Furthermore, it would not be wise for damp wood or fabric to remain in contact with aluminum for a prolonged period.

The above very obvious and simple precautions do not in any way detract from the confidence with which the metal can be almost universally applied.

As in the case of other metals, long endurance is assured by a high degree of purity. For a maximum of endurance and maintenance of good surface, it is strongly advisable that virgin metals should be specified.

The British Aluminium Co., Ltd., is an experienced producer of virgin aluminum and alloys of the highest qualities. Its engineering staff are always ready to give advice on the utilization of the metal.

The specification of British Aluminum will give certainty that the best obtainable material enters the product.

TABLE 1

PHYSICAL PROPERTIES OF ALUMINUM

Specific Gravity	2.705
Density: Weight per cubic inch	0.975 pounds
Weight per cubic foot	168.4 pounds
Specific Heat	0.214
Relative Heat Conductivity . .	51.8% of conductivity of silver
Electrical Conductivity	61% of International Annealed Copper Standard
Melting point	658° C. (1217° F.)
Coefficient of expansion . . .	23.0×10^{-6} per ° C. (12.8×10^{-6} per ° F.)
Modulus of Elasticity	9.6×10^{6} pounds per square inch
Modulus of Rigidity	3.87×10^{6} pounds per square inch
Poisson's Ratio	0.36

TABLE 2

TENSILE PROPERTIES OF ALUMINUM AND ALUMINUM ALLOYS

Material	Composition		Condition	Tensile Strength* pounds per sq. inch
Commercial pure aluminum	Purity	99–99.5%	Annealed sheets.	12000 (Elongation 40%)
			Extruded sections.	12000
			Hard-rolled sheets.	20000
95/5 aluminum silicon alloy . . .	Silicon	5%	Sand castings.	18000 (Elongation 3%)
			Extruded sections.	18000
			Half-hard sheets.	23000
"Y" alloy	Copper	4%	Heat-treated sand-castings.	33000
	Nickel	2%		
	Magnesium	1½%		
Duralumin	Copper	4%	Heat-treated sheets, plates, bars.	55000 (Elongation 17%)
	Magnesium	.4%		
	Manganese	.7%		
SAE No. 28	Magnesium	.7%	Heat-treated sections, sheets.	35000 (Elongation 20%)
	Silicon	.9%		
1¼% Manganese Alloy	Manganese	1.25%	Half-hard sheets.	21000

* Conservative figures given